submit a Terminal Disclaimer in the present case to obviate the rejection of obviousness-type double patenting, if required.

Claim 19 stands rejected under 35 U.S.C. §119, second paragraph, as being indefinite because, as the Examiner correctly notes, the lower limits of silicon ("005") and yttrium ("001") are apparent typographical errors. These obvious typographical errors have been corrected herein to make the values correctly read --0.05-- and --0.01-- for the respective lower limits of silicon and yttrium. Support for these values may be found in Table 1 on page 5 of the instant application under the heading "Nominal Range" for silicon and yttrium. The rejection under 35 U.S.C. §112, second paragraph, has thus been overcome.

Claims 1, 4-7, 10-13 and 16-20 stand rejected under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103 as being unpatentable over the previously applied Shankar et al., Sileo et al., or Grant references.

Claims 1 and 4-6 stand rejected under 35 U.S.C. §102(b) or, alternatively, under 35 U.S.C. §103 as being anticipated by or rendered obvious over U.S. Patent No. 5,900,078 to Yakuwa et al.

All of the pending independent claims 1, 7, 13 and 20 have been amended herein. It should also be noted that all of the claims were previously amended to eliminate the modifier "about" with respect to the claimed constituent ranges.

The Present Invention

The present invention is directed to a nickel base alloy which provides high temperature and high strength applications involving corrosion-inducing environments over a complete spectrum of carburizing, oxidizing, nitriding and sulfidizing atmospheres. When optimum levels of chromium, aluminum and critical microalloying levels of yttrium and zirconium are present in the alloy, outstanding corrosion resistance will be achieved in this

complete spectrum of carburizing, oxidizing, nitriding and sulfidizing corrosion-inducing environments. That feature is now present in all of the claims by way of amendment.

As pointed out on page 3, lines 30-32 of the instant specification, maximum overall corrosion resistance to carburizing, oxidizing, nitriding and sulfidizing environments is achieved by a combination of alloy constituents containing at least 2.75 wt.% Al, 0.01 wt.% Zr and 0.01 wt.% Y along with the optimum amount of chromium. These limitations are now present in all pending claims.

An addition of 21.5-27 wt.% chromium as required in claim 1 imparts oxidation resistance to the alloy. Chromium levels less than 21.5 wt.% are inadequate for oxidation resistance, while levels above 27 wt.% chromium can produce detrimental chromium-containing precipitates. The instant specification points out that an addition of 4.5-9.5 wt.% molybdenum contributes to stress corrosion cracking resistance and contributes solid solution strengthening to the matrix of the material. Aluminum in an amount ranging from 2-3.5 wt.% contributes to oxidation resistance and precipitates as γ' phase to strengthen the matrix at intermediate temperatures. As pointed out above, aluminum contents of at least 2.75 wt.% provide maximum oxidation resistance.

It is also critical in the present invention for sulfidization resistance that the alloy contain a minimum of 0.01 wt.% zirconium to stabilize the scale against inward migration of sulfur through its protective layer. Zirconium additions above 0.6 wt.% adversely impact the alloy's fabricability. Advantageously, an addition of at least 0.005 wt.% and, more preferably, at least 0.01 wt.% yttrium improves both oxidation and nitridation resistance of the alloy and is critical to establish carburization resistance. The present specification further points out that yttrium levels above 0.1 wt.% increase the cost and decrease the hot workability of the alloy. When the claimed optimum levels of chromium, aluminum and critical microalloying levels of yttrium and zirconium are present, the

balanced outstanding corrosion resistance is achieved and corrosion resistance in the complete spectrum of carburizing, oxidizing, nitriding and sulfidizing environments is obtained. Clearly, <u>no such combination of properties or critical ranges is taught or suggested in any of the cited prior art</u>.

<u>U.S. Patent No. 4,764,225 to Shankar et al.</u>

For example, Shankar et al. discloses in column 3, lines 7-50, and at column 4, lines 8-24, cited by the Examiner, extremely broad ranges of 4-40% chromium, for example, as well as up to 10% aluminum, up to 5% yttrium and up to 1% zirconium, up to 30% molybdenum, all as optional additions. The Examiner has seemingly ignored the preferred compositional ranges taught by Shankar at column 3, line 51 bridging to column 4, line 7, which provides 5-10 wt.% cobalt, 8-16 wt.% chromium, 3-7 wt.% aluminum, 1-3 wt.% titanium, and up to 5 wt.% yttrium. Persons skilled in the art are thus directed to these preferred ranges of Shankar. Shankar's teachings are contrasted with Applicants' claimed cobalt range in claim 1, for example, of 12-18 wt.% cobalt, 21.5-27 wt.% chromium, 2-3.5 wt.% aluminum and 0.005-0.1 wt.% of yttrium and/or 0.01-0.6 of zirconium. These elements are all critical in obtaining the claimed overall corrosion resistance to oxidizing, nitriding, carburizing and sulfidizing environments. Shankar merely teaches resistance to <u>oxidizing</u> and <u>sulfidizing</u> environments, see col. 2, lines 20-24. Likewise, Applicants teach and claim that carbon levels should be restricted to no more than 0.15 wt.% and point out on page 4 of the present specification, at lines 14-15, that carbon levels above 0.15 wt.% can precipitate detrimental carbides. Shankar, on the other hand, permits carbon additions up to 3 wt.%. Shankar's failure to teach or suggest the criticality of the zirconium, yttrium, titanium, molybdenum, cobalt and chromium ranges in achieving optimum corrosion resistance in

carburizing, oxidizing, nitriding and sulfidizing environments fails to negate the patentability of the instantly claimed invention.

The Examiner states that "overlapping ranges have been held to be a *prima facie* case of obviousness...." (citations omitted). This statement is hardly applicable in the present case where Shankar discloses broad ranges of, for example, 5-40% Cr, up to 10% Al, up to 10% Ti, up to 30% of Ta, W, Mo, Nb, Rh or V when contrasted to Applicants's narrowly claimed ranges of Cr, Al, Ti and Mo.

U.S. Patent No. 5,780,116 to Sileo et al.

This is, likewise, true of Sileo which fails to teach or suggest the critical combination of alloy constituents set forth in Applicants' pending claims to obtain the optimum corrosion resistant properties in the carburizing, oxidizing, nitriding and sulfidizing environments. The Examiner has completely ignored the relevant and specific teaching of Sileo of the alloy compositions set forth in Table 1 appearing in column 7 thereof. None of the enumerated alloys 1, 2 or 3 of Sileo discloses or suggests the critical molybdenum content of the present invention. This cannot create an anticipation, nor does it establish *prima facie* obviousness since there is no overlap. Sileo teaches 0-4.0 molybdenum while Applicants, in claim 1, for example, require a molybdenum content of 4.5-9.5 wt.%, claim 7 requires 4.5-9 wt.% Mo, claim 13 requires 5-8.5 Mo and claim 20 requires 5-8 Mo. Hence, neither anticipation nor *prima facie* obviousness is present.

U.S. Patent No. 3,015,558 to Grant et al.

The same is true with respect to the Grant reference. In particular, Grant teaches a broad Cr range of 28-45 at col. 2, line 28 and a preferred Cr range of 30-40% at col. 2, lines 25. Applicants' claims 1, 7 and 13 set a Cr maximum of 27% and claim 20 has a Cr

maximum of 26%. Hence, there is no anticipation or overlap of Cr ranges. Grant fails to anticipate or render obvious Applicants' claimed invention with respect to the failure to overlap the claimed chromium ranges. Nor does Grant teach the addition of both yttrium and zirconium, which are critical in the present invention as pointed out above. Both yttrium and zirconium are optional additions in Grant, col. 2, line 38. Criticality of Y and Zr has been established in the present application. See, for example, Table 9 appearing on page 11 of the instant application which compares alloys of the present invention containing Zr with alloy A which contains no Zr, as in the Grant reference. The data show that alloys containing a minimum Zr content of about 0.01 wt.% are unexpectedly, extremely resistant to sulfidation compared to alloy A. Table 10 shows comparable results with respect to nitridation resistance where both Zr and Y are required in the claimed amounts.

U.S. Patent No. 5,900,078 to Yakuwa et al.

Yakuwa was applied against claims 1 and 4-6 under 35 U.S.C. §102(b) as anticipated by or, in the alternative, under 35 U.S.C. §103 as being obvious thereover. Yakuwa does not render obvious or anticipate the presently pending claims due to its disclosure of a chromium range of 18-21 wt.%, which does not overlap any of the instant claims. In addition, Yakuwa completely fails to disclose or suggest the addition of the critical yttrium constituent which is present in all of the pending claims.

Note that the alloy of Yakuwa is intended only to be resistant to high temperature sulfidation corrosion, col. 2, lines 23-24, whereas, in addition, Applicants' claimed alloy is also resistant to nitriding, oxidizing and carburizing environments.

Additional Arguments

In applying the Grant reference in paragraph 10 of the Office Action, the Examiner stated: "Grant teaches about 28-45 wt.% Cr which is “about” the same as claimed Cr contents (instant claims 4, 7 and 10 “about” 27 wt.% Cr; claim 19 “about” 26 wt.% Cr)....Moreover, it is well settled that a *prima facie* case of obviousness would exist where the claimed ranges and prior art do not overlap but are close enough that one skilled in the art would have expected them to have the same properties," the Examiner citing *In re Titanium Metals Corporation of America v. Banner*, 227 USPQ 773 (Fed.Cir. 1985), and others. It should be pointed out, once again, to the Examiner that the modifier "about" has been deleted from all of the pending claims. Hence, the word "about" should not be used in an attempt to enlarge the upper limit of Applicants' chromium contents.

It is further submitted that 28% does not overlap and cannot be considered "close enough to" 27% or 26 wt.% in the same context as the *Titanium Metals Corporation* case. That case, as well as the other cases cited, are misapplied by the Examiner. The prior art in the *Titanium Metals* case disclosed a titanium base alloy containing 0.25 % by weight Mo and 0.75% nickel which fell squarely within the ranges of 0.2-0.4% Mo and 0.6-0.9% Ni of claims 1 and 2 in the application on appeal. Claim 3, at issue in the reported *Titanium Metals* case, had a composition of 0.3% Mo and 0.8% Ni, balance titanium. Two of the titanium base alloys in the prior art contained 0.25% Mo-0.75% Ni and 0.31% Mo-0.94% Ni, respectively. The statement made by the Examiner, "The proportions are so close that *prima facie* one skilled in the art would have expected them to have the same properties" was made with reference to these comparisons, wherein the alloys of the prior art contained all of the constituents of the claimed alloy. In addition, the prior art reference in the *Titanium Metals* case disclosed actual examples which were squarely within the claimed ranges and, thus, anticipated the ranges set forth in claims 1 and 2 of the application at issue.

In the case of *In re Woodruff*, 16 USPQ2d 1934 (Fed.Cir. 1990), the patent at issue contained claims directed to a process for inhibiting fungal growth on refrigerated fresh fruits and vegetables. The claims at issue (claims 27 and 31) contained limitations on Co_2, O, Co, N_2 and temperature. The prior art McGill patent disclosed each and every one of these limitations and, except for the CO contentration, all of the ranges of gas concentrations and temperatures set forth in the McGill patent were <u>completely within</u> the range recited in claims 27 and 31. No such prior art is cited against the present application.

Similarly, in *In re Aller*, 105 USPQ 233 (CCPA 1955), the patent application on appeal involved process claims wherein the process claimed was identical with that of the cited prior art reference except that the claims recited lower temperatures and higher sulfuric acid concentrations. The question before the court was whether the changes in temperature and in acid concentration amount to invention. The Court noted at 105 USPQ 235::

> "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. Such ranges are termed 'critical' ranges, and the applicat has the burden of proving such criticality." [citations omitted]

It is submitted that Applicants have shown new and unexpected results by the comparative tests run against the very similar Alloys A, B, C and D and reported in the tables discussed above so as to provide an alloy composition with critical additions, including Al, Zr and Y, which is resistant to the broad spectrum of carburizing, oxidizing, nitriding and sulfidizing environments.

The present case is clearly distinguishable over the cases cited by the Examiner since the cited prior art does not duplicate all of the claimed constituents, nor are the ranges disclosed in the prior art as close as comparative Alloys A, B, C and D set forth in

the present application. Hence, it is improper to assume in the present application that the cited prior art would possess the same properties as the claimed alloys. Indeed, Applicants' test results reported in Tables 3 to 10 amply demonstrate the criticality of the various constituents such as Al, Zr, Ti and Y. More specifically, see Tables 6 and 7 for the comparative oxidation resistance data which show the significant contribution of aluminum. The Applicants' data show that the enhanced oxidation resistance is progressively increased at 1200°C with increasing aluminum content and further enhanced by the microalloying addition of yttrium in alloy 8. Scale integrity at 1100°C is enhanced as shown by the positive mass changes by additions of yttrium, zirconium and nitrogen and maintained at 1200°C as seen in Table 7. Resistance to carburization is shown in Table 8 versus alloy A which contained no microalloying additions of Zr, Y and/or N. The application, as filed, clearly demonstrates unexpected properties obtained over these critical narrow ranges.

The criticality of Al, Zr, Ti and Y ranges in achieving unexpected results of the combined resistance to carburizing, nitriding, oxidizing and sulfidizing environments is clearly established in the present application by side-by-side tests run against comparative alloys A, B, C and D. Comparative alloys A, B, C and D are closer in composition to Applicants' claimed alloy than any of the prior art cited by the Examiner. As seen in Table 2 of the instant application, the compositions of comparative alloys A, B, C and D ("the Comparative Alloys") substantially fall within the claimed ranges of the instant claims with the exception of the critical Al, Zr and Y contents. It is, therefore, submitted that the Comparative Alloys A, B, C and D represent a fair reconstruction of the presently claimed alloys for side-by-side test purposes. The comparative test results conclusively show the progressive increase in oxidation resistance with critical additions of aluminum, yttrium and zirconium, see Tables 6 and 7, over Comparative Alloys A, B, C and D. Likewise, carburization resistance as a function of Al, Zr and Y content (Alloy A) is demonstrated in

Table 8. Sulfidation resistance is also discussed on pages 10-11 of the instant application. Applicants discovered that alloys containing a minimum of about 0.015% Zr are unexpectedly extremely resistant to sulfidation as exemplified by the data of Table 9. Finally, nitridation resistance is demonstrated in Table 10 which establishes the criticality for having at least 2.75% Al plus both Zr and Y in the claimed amounts.

In light of the amendments made hereinabove, taken with the above comments, the Examiner's reconsideration and favorable action with respect to claims 1, 4-7, 10-13 and 16-20 are respectfully requested.

Respectfully submitted,

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MARKED-UP VERSION OF CHANGES MADE

IN THE CLAIMS:

1. (Four Times Amended) A nickel-base alloy resistant to carburizing, oxidizing, nitriding and[/or] sulfidizing environments, consisting of, in weight percent, 42 to 58 nickel, 21.5 to [28] 27 chromium, 12 to 18 cobalt, 4.5 to 9.5 molybdenum, 2 to 3.5 aluminum, 0.05 to 2 titanium, [at least one microalloying agent selected from the group consisting of] 0.005 to 0.1 yttrium and 0.01 to 0.6 zirconium, 0.01 to 0.15 carbon, 0 to 0.01 boron, 0 to 4 iron, 0 to 0.4 manganese, 0 to 1 silicon, 0 to 1 hafnium, 0 to 0.4 niobium, 0 to 0.1 nitrogen, incidental impurities and deoxidizers.

4. (Three Times Amended) The alloy of claim 1 including 43 to 57 nickel, [21.5 to 27 chromium] and 12.5 to 17.5 cobalt.

7. (Three Times Amended) A nickel-base alloy resistant to carburizing, oxidizing, nitriding and[/or] sulfidizing environments, consisting of, in weight percent, 43 to 57 nickel, 21.5 to 27 chromium, 12.5 to 17.5 cobalt, 4.5 to 9 molybdenum, 2.25 to 3.5 aluminum, 0.06 to 1.6 titanium, [at least one microalloying agent selected from the group consisting of] 0.01 to 0.08 yttrium and 0.01 to 0.5 zirconium, 0.01 to 0.14 carbon, 0.0001 to 0.01 boron, 0 to 3 iron, 0 to 0.4 manganese, 0.01 to 1 silicon, 0.01 to 0.8 hafnium, 0.00001 to 0.08 nitrogen, incidental impurities and deoxidizers.

13. (Three Times Amended) A nickel-base alloy resistant to carburizing, oxidizing, nitriding and[/or] sulfidizing environment, consisting of, in weight

percent, 44 to [50] 55 nickel, 22 to 27 chromium, 13 to 17 cobalt, 5 to 8.5 molybdenum, 2.5 to 3.5 aluminum, 0.08 to 1.2 titanium, 0.01 to 0.07 yttrium, 0.02 to 0.5 zirconium, 0.01 to 0.12 carbon, 0.001 to 0.009 boron, 0.1 to 2.5 iron, 0 to 0.4 manganese, 0.02 to 0.5 silicon, 0 to 0.7 hafnium, 0.0001 to 0.05 nitrogen, incidental impurities and deoxidizers.

19. (Twice Amended) The nickel base alloy of claim 13 containing 2.75 to 3.5 aluminum, 0.003 to 0.008 boron, 0.02 to 0.1 carbon, 14 to 16 cobalt, 22 to 26 chromium, 0.5 to 2 iron, 0 to 0.5 hafnium, 5 to 8 molybdenum, 0.01 to 0.05 nitrogen, 0 to 0.2 niobium, 45 to 55 nickel, [005] 0.05 to 0.4 silicon, 0.1 to 1 titanium, [001] 0.01 to 0.06 yttrium and 0.02 to 0.4 zirconium.

20. (Once Amended) A nickel-base alloy resistant to carburizing, oxidizing, nitriding and sulfidizing environments consisting of, in weight percent, [42 to 58] 45 to 55 nickel, [21.5 to 28] 22 to 26 chromium, [12 to 18] 14 to 16 cobalt, [4.5 to 9.5] 5 to 8 molybdenum, [2] 2.75 to 3.5 aluminum, [0.05 to 2] 0.1 to 1 titanium, [0.005 to 0.1] 0.01 to 0.06 yttrium, 0.01 to [0.6] 0.4 zirconium, [0.01 to 0.15] 0.02 to 0.1 carbon, [0 to 0.01] 0.003 to 0.008 boron, [0 to 4] 0.5 to 2 iron, 0 to [1] 0.4 manganese, [0 to 1] 0.05 to 0.4 silicon, 0 to [1] 0.5 hafnium, 0 to 0.4 niobium, [0 to 0.1] 0.01 to 0.05 nitrogen, incidental impurities and deoxidizers.